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Title: Bistable Magnetic Drive For A Switch

Specification

001 The invention relates to a bistable magnetic drive for a switch, in particular for an electric switch, comprising an armature that can be moved linearly back and forth between two end positions inside a space and which operates jointly with at least one movable switch contact, further comprising a shunt member arranged essentially on the axis of displacement for the armature and at a distance thereto which is composed of a magnetizable material, and comprising means for generating a magnetic field which exerts a force onto the armature for holding the armature in place in the end positions, wherein by joining the armature and the shunt member, the course of the flux lines of the magnetic field is changed in such a way that the holding force exerted onto the armature is reduced.

002 Magnetic drives of the aforementioned generic type are primarily used in the field of electric switch technology, in particular for power switches which, under specified conditions, switch on and interrupt rated currents or overcurrents, as well as isolate electrical circuits against each other. Since these switches have two stable states, namely an open state where the electrical isolation of the respective circuits is maintained and a closed state in which the fixed rated current flows continuously and an overcurrent is resisted for a specific period of time, it is in particular necessary that the basic drives for the switches also have two stable states, meaning rest states, which require holding forces.

003 A bistable magnetic drive for an electric switch of the above-described type is known from the document DE-OS 196 19 835, to which we refer fully in connection with the present invention. This magnetic drive is provided with an armature that can be displaced linearly between two end positions, is connected to at least one movable switching contact and is kept stable in the end positions as a result of the influence of magnetically generated forces. Furthermore provided is a ferromagnetic shunt member, wherein the armature and the shunt member are arranged one behind the other in a space between a first and a second end stop. The end stops are embodied as pole surfaces for magnetic circuits, generated by a pair of permanent magnets for keeping the displaceable armature in the two stable end positions. Additionally provided is a pair of electromagnets, the variable magnetic field of which functions to move the armature between the two stable end positions. If joined to the armature, the shunt member in particular functions to reverse the direction of the force exerted by the permanent magnets onto the armature, if applicable with a force exerted from the outside onto the armature, and to transfer the force to the shunt member, thereby causing the shunt member and the armature to be displaced to their second stable end position and to be held in this position.

004 Depending on whether the armature and the shunt member are separated or fit against each other, the magnetic circuit is consequently embodied such that the force lines of the permanent magnets will close outside of the armature and the shunt member in such a way that the force emanating from the permanent magnet is respectively directed toward one of the two movement directions of the armature and/or the shunt member.

005 With the known drive, the armature can occupy two stable positions. In one position it rests against the first end stop and in the other position it rests against the shunt member which, in turn, rests against the second end stop when the armature is in the second stable position. It is thus prevented that the armature, which drives the moving contact, is "hung up" in an intermediate position between the end positions. Once the reversal of the armature position has been initiated as a result of the electromagnet being switched on or the shunt member

making contact with the armature, the switchover occurs automatically and fast. Despite the selection of a relatively low opening energy, no stable intermediate position between the two end positions of the armature is possible, meaning that once a reversing operation has started, it leads of necessity to an opening or closing of the switch.

006 A special requirement to be met with the switches addressed herein is to ensure a functionally secure and, in particular, the fastest possible shutdown, especially in an emergency situation ("emergency shutdown"). Known switches are therefore provided with expensive mechanical attachments (e.g. lever arrangements) which make it possible to move the armature to the 'OFF' position of the switch. A shutdown is thus possible only with relatively high energy expenditure.

007 It is therefore the object of the present invention to improve a magnetic drive of the aforementioned type in such a way that the force and energy expenditure required for the shutdown of the power switch operated with the drive is minimized and the operating safety is increased on the whole, in particular such that an emergency shutdown can be effected as quickly as possible and operationally safe. With respect to its production, the technical design of the drive should at the same time be as simple as possible so that the production costs can be minimized in the final analysis. In addition to these requirements, the goal furthermore is not to abandon the use of a shunt member of the aforementioned type with the special advantage of the lower force expenditure during the armature movement.

008 This object is solved according to the invention with a magnetic drive of the aforementioned type by providing a locking mechanism for the shunt member, by means of which the shunt member can be held in the end position facing it and can be released from this end position with low energy/force expenditure. Especially in the case of an emergency shutdown of the operating electric switch, this locking mechanism can relatively quickly move the shunt to make contact with the armature and with low energy/force expenditure

009 According to the invention, the shunt member is consequently used advantageously for shutting down the switch, wherein the movement speed of the shunt member in particular is determining for the shutdown time. The proposed mechanical holding device in particular meets this requirement by allowing the shunt member to be released with low energy/force expenditure from its holding position and thus also relatively quickly.

0010 According to a first exemplary embodiment of the invention, the strict safety requirements for an uninterrupted shutdown operation of a switch operated with the magnetic drive according to the invention can be met, in particular for the case of an emergency shutdown, by locking the shunt member in place in the end position with the aid of mechanical holding means. As compared to electric and magnetic holding devices, the proposed mechanical holding device for the shunt member is less susceptible to interference, for example, and is also still fully functional even in emergency situations which often go hand-in-hand with a loss of power.

0011 According to one preferred embodiment of the inventive magnetic drive, the mechanical holding means are realized with the aid of a mechanical locking mechanism which holds the shunt member in the end position facing the shunt member, wherein a spring force acts upon the shunt member to move it in the direction of the armature once the lock is released. With this embodiment, the shunt member is provided with a supporting force for the movement in the direction toward the armature, e.g. exerted by a mechanical compression spring, wherein this force counteracts the force exerted by the permanent magnet or magnets and automatically acts upon the shunt member as soon as the mechanical holding device of the shunt member is deactivated.

0012 With the mechanical holding means, it can be provided in particular that a mechanical locking mechanism for the shunt member comprises a guide rod that is connected to the shunt member and is also connected pivoting to a lever arm that cooperates with a sensing device.

0013 Alternatively, a mechanical threshold or block can also be provided for the mechanical holding means which functions to hold the shunt member with a low

holding force and lightly in the end position facing the shunt member, so that the shunt member can be released from this end position by overcoming this low force potential and can be joined with the armature.

0014 According to a different embodiment of the magnetic drive according to the invention, the shunt member can be locked in place in the end position with the aid of magnetic holding means.

0015 Additional features, details and advantages of the invention follow from the enclosed claims as well as from an exemplary embodiment of the magnetic drive according to the invention, shown in the drawing.

0016 The drawing shows:

Figure 1 A median voltage or high voltage power switch with a linear magnetic drive according to the invention, as seen from the side in a partial sectional view;

Fig. 2a, b A schematic view from the side of a magnetic drive according to the invention with an armature and shunt member, showing respectively two different positions;

Figure 3 The exemplary embodiment of the magnetic drive in Figures 2a and 2b, shown in a schematic view from the side with a detailed representation of a mechanical locking mechanism according to the invention for the shunt member;

Figs. 4a-c Views from the side of three different operating phases for the magnetic drive according to Figure 3;

Figs. 5a-e Schematic views from the side of the magnetic drive according to the invention during six different operating phases and the corresponding magnetic field lines.

0017 One example for the use of the magnetic drive according to the invention for a median and high voltage power switch is explained first with reference to Figure 1. A power switch 1 has three switching poles 2, 3, 4, which respectively comprise a switching chamber 5 that contains one immobile switching contact, not shown in further detail herein, and one mobile switching contact that is also

not shown herein. The switching chamber 3 [sic][1], e.g. a vacuum switch, is of a standard design. The mobile contact is connected to a shaft 7 which is positioned so as to be displaceable along a shaft 6 through pre-tensioning of a spring 8. In the switched on and/or closed position of the power switch, the springs 8 of the switching poles 2, 3, 4 are tensioned, meaning the springs 8 will relax when the power switch is opened. As a result, the shaft 7 movement that is necessary for a switching off is supported by the springs 8 and/or by a so-called "switching off spring" ('44' in Figure 1). The shaft 6 is rigidly connected to a rod 9 which is hinged, for example via a bolt 10, to one end of a toggle joint 11 that is positioned pivoting and is connected articulated with its other end to a rod 13, positioned at a right angle to the rod 9 inside a housing 12, so as to be displaceable. The housing 12 accommodates the switch poles 2, 3, 4 that are arranged in a row.

0018 Attached to one end of the rod 13 is the one end of an additional toggle joint 14 that is positioned pivoting inside the housing 12 and is attached articulated with its other end to a rod 15 which, in turn, is connected with its other end to a linear magnetic drive 16 according to the invention.

0019 A preferred exemplary embodiment of the magnetic drive according to the invention is described in the following section, wherein identical components shown in the different Figures are given the same reference numbers.

0020 The linear magnetic drive 16 shown in Figures 2a and 2b (Figure 2a for an opened switch 1 and Figure 2b for a closed switch) is provided on the outside with a rectangular yoke 20 of magnetizable material, for example composed of a laminated soft iron. The outer shape of the yoke is not important to the invention and can be selected freely from among all conceivable forms, e.g. as a cylindrical shape. A recessed space 21 exists on the inside of the yoke 20 in which two pole shoes 22, 23 project on opposite sides toward the inside. Permanent magnets 24, 25 are respectively arranged on the inside surfaces of the pole shoes. However, the permanent magnets 24, 25 can also be embodied as one part and can thus surround ring-shaped the space 21 at the level of the pole shoes. The permanent magnets 24, 25 face each other with the same poles and thus form a magnet pair.

[1] Note: Previously given the reference "switching chamber 5"

0021 An armature 26 and a shunt member 27 are arranged moving in linear direction inside the space 21 in the yoke 20. The armature 26 and the shunt member are advantageously made of a magnetizable material, preferably of a magnetizable metal. The movement space for the armature 26 and the shunt member 27 is delimited at one end by a first end stop 28 and at the other end by a second end stop 29. On the side, the movement space of the armature 26 is furthermore delimited by the permanent magnets 24, 25.

0022 Respectively one coil 30 for opening the switch 1 as well as a coil 31 for closing the switch 1 are provided in additional recesses of the yoke, above the permanent magnets and outside of the movement space 21. The magnetic field generated by the coil 31 also permits or causes an armature movement in the direction of the upper end stop 29 whereas the magnetic field generated with the aid of the coil 30 permits or causes an armature movement in the direction of the shunt member 27.

0023 The movement space for the armature 26 and the shunt member 27 is delimited toward the top by an upper plate 33, inserted into the recess of the yoke, and toward the bottom by a corresponding plate 34.

0024 The armature furthermore contains a through bore 35 into which a bolt is inserted, not shown further herein, for attaching the armature 26 to a shaft 36 that extends through the yoke 20, the shunt member 27 and the armature 26. The movement of the armature 26 is transmitted via the shaft 36 to the switch arrangement shown in Figure 1, for example via the toggle joint 14 shown in Figure 1.

0025 With this exemplary embodiment, the shunt member 27 is held in position at the lower end stop 28 of the lower plate 34 with the aid of a locking mechanism. In particular, the shunt member 27 has a guide rod 37 attached to it which, in turn, is connected pivoting to a joint 38. A cog 39 that cooperates with a half-wave plate 40 holds the joint 38 in the rotational position, shown herein for the half-wave plate 40, thus causing the shunt member 27 to be held against the lower end stop 28.

0026 The shunt member 27 of an alternative embodiment that is held in place with the aid of a mechanical threshold or block (not shown in the drawing) can be embodied, for example, as retaining spring where the shunt member 27 can be 'triggered' by overcoming a spring force potential. Holding devices of this type are known to one skilled in the art from numerous areas of technology.

0027 With the situation shown in Figure 2b, the armature 26 rests against the upper end stop 29 of the upper plate 33 and the shunt member 27 again comes to rest against the armature 26. The movement of the shunt member 27, required for this, is initially triggered by rotating the half-wave plate 40 so that the cog 39 no longer rests against the upper half-wave plate 40 and the joint 38 consequently can move freely. As a result of the spring force of a compression spring 41 the shunt member 27 thus moves in the direction of the clearance space that opens up owing to the movement of the armature 26, until it comes to rest against the armature 26.

0028 Figure 3 shows in further detail a preferred embodiment of a locking mechanism according to the invention. For this exemplary embodiment, a bolt and/or a yoke 42 is attached to the half-wave plate 40 which carries out the rotational movement of the half-wave plate, required for operating the locking mechanism, via an externally controlled movement mechanism, here a manually actuated switch 43. The pivoting connection between the guide rod 37 and the joint 38 for the exemplary embodiment is realized with a bolt 44, attached to the guide rod 37, which engages in a recess 45 provided at one end of the joint 38. The design shown herein for the through bore 45 is for the most part predetermined because of the play resulting from the rotational movement of the joint.

0029 Different operating phases of the magnetic drive according to the invention are described in Figures 4a to 4c.

0030 In Figure 4a, the armature is located in one of the two stable end positions, wherein the switch 1 that is operated by the magnetic drive is in the "open" position ("OFF"). In this stable end position, the armature 26 as well as the shunt

member 27 respectively make contact and are located at the lower end stop surface 28 of the yoke 20.

0031 With the situation shown in Figure 4b, the armature 26 has moved upward as a result of the magnetic field generated on the whole though super-imposition by the permanent magnets 25 and the electromagnet 31 and now rests against the upper end stop surface 29. This second, stable end position of the armature 26 in particular is distinguished by the separation of the armature 26 and the shunt member 27. This separation is caused by the locking mechanism shown in Figure 3. In contrast, the stability of the end position shown herein for the armature 26 is essentially caused by the effect of the field emanating from the permanent magnets 25. The phenomenology of the underlying magnetic field and its force acting upon the armature 26 are explained in further detail with the aid of Figures 5a to 5f.

0032 The stable end position shown in Figure 4b is again changed to an unstable state with the aid of the shunt member 27, wherein this corresponds to the situation shown in Figure 4c. By releasing the locking mechanism, the shunt member 27 has moved in the direction of the armature 26 as a result of the spring effect of the compression spring 41 and is now resting against the armature. Based on the resulting change in the course of the magnetic flux lines, a force reversal in downward direction now occurs, which makes it possible for the armature 26 and the shunt member 27 to jointly move downward once more with relatively little force expenditure, thereby again resulting in the situation shown in Figure 4a where the armature 26 occupies the other stable end position.

0033 Figures 5a to 5e show simplified, in part sectional side views of the drive according to the invention, already shown in Figures 2 to 4. Shown are in particular the positions of the armature 26 and the shunt member 27 during five different operating phases of the magnetic drive. To better illustrate the mode of operation, the magnetic field lines 50 present during the individual operating phases are also drawn in schematically.

0034 The partial Figure 5a in this case shows the drive in the open position ("OFF") for the power switch. The partial Figure 5b shows the situation at the start of the

armature 26 movement toward the closed position ("ON") for the power switch. The partial Figure 5c illustrates the magnetic field distribution during the start-up phase, wherein the armature 26 is in a position halfway toward the closed position for the power switch. In the partial Figure 5d, the magnetic field distribution is shown for the closed position ("ON") of the power switch and in the partial Figure 5e, the phase is shown at the start of the armature movement to the open position ("OFF") for the power switch, wherein the shunt member 27 was first moved to a position of contact with the armature 26.

0035 During the operating phases of the magnetic drive, shown in the partial Figures 5a to 5d, the shunt member is held with the aid of the holding device according to the invention (not shown herein) against the lower end stop, so that the armature 26 - by separating from the shunt member 27 - can move under the effect of the magnetic field 51 toward the upper end stop 29.

0036 In Figure 5e, the shunt member 27 moves in the direction toward the armature 26, as a result of the force exerted by the spring 41, and makes contact with the armature after the locking mechanism (not shown herein) has been released.

Patent Claims

1. A magnetic drive for a switch, in particular for an electric switch (1), comprising an armature (26) which can be displaced in linear direction between two end positions inside a space (21) and cooperates with at least one moving switch contact, further comprising a shunt member (27) of a magnetizable material that is essentially arranged on the displacement axis for the armature (26) and at a distance thereto, as well as means (24, 25, 29, 31) for generating a magnetic field which exerts a force onto the armature (26) for holding it in the end positions (28, 29), wherein by joining the shunt member and the armature (26), the course of the flux lines for the magnetic field is changed in such a way that the holding force exerted onto the armature (26) is reduced, characterized by a locking mechanism for the shunt member (27), by means of which the shunt member (27) can be kept in the end position (28) facing it and can be released from this end position (28) with low energy/force expenditure.

2. The magnetic drive according to claim 1, characterized in that the shunt member (27) can be secured in the end position (28) with the aid of mechanical holding means (37-40, 42-45).

3. The magnetic drive according to claim 2, characterized in that a mechanical locking mechanism (37-40, 42-45) is provided as mechanical holding device, by means of which the shunt member (27) can be held in place in the end position (28) and that a spring force (41) acts upon the shunt member (27) in the direction of the armature (26) after the locking mechanism is released.

4. The magnetic drive according to claim 2, characterized in that a mechanical threshold is provided as mechanical holding means for holding in place the shunt member (27) in the end position (28) and can be joined with low energy/force to the armature (26).

5. The magnetic drive according to claim 1, characterized in that the shunt member (27) can be locked in place in the end position (28) with the aid of magnetic holding means.

6. The magnetic drive according to claim 3, characterized in that the mechanical locking mechanism (37-40, 42-45) for the shunt member (27) is provided with a guide rod (37) that is connected to the shunt member (27) and is also connected pivoting to a lever arm (38) which cooperates with a sensing device.

7. The magnetic drive according to one or several of the claims 1 to 6, characterized in that the electric switch (1) is closed in the end position of the armature (26), facing away from the shunt member (27) and is open in the end position of the armature (26) facing the shunt member (27).

8. The magnetic drive according to one or several of the claims 1 to 7, characterized in that the armature (26), the yoke (20) and the upper plate (33) are provided with slots for reducing eddy flows.

Abstract

A magnetic drive for an electric switch is provided with an armature (26), displaceable in linear direction between two end positions, a shunt member (27) that is arranged at a distance thereto, as well as means (24, 25, 30, 31) for generating a magnetic field. The armature (26) is kept in the end position by the force exerted by the magnetic field, wherein after the shunt member (27) and the armature (26) are joined, the course of the flux lines of the magnetic field is changed, such that the holding force of the armature (26) is reduced and the armature, if applicable, is displaced to the respectively other end position with a force that acts from the outside onto the armature (26) and is held in this position by the magnetic field. The shunt member (27) is used for the shutdown, wherein after making contact with the shunt member (27), the armature (26) is moved from the end position facing away from the shunt member (26) [sic][2] to the end position facing the shunt member (26) [sic]. Holding means (37-40, 42-45), in particular, are provided which hold the shunt member (27) in the position facing it and by means of which the shunt member can be joined to the armature (26) with low energy/force expenditure if the switch (1) is cut off.

(Figure 3)

[2] Note: The German text is very confusing here and there are problems with the reference numbers (26/27)

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[EMBLEM]

Certificate

The company E.I.B.S.A, located in Dison/Belgium, has filed a patent application with the following title:

"Bistable Magnetic Drive For A Switch"

with the German Patent and Trademark Office on March 9, 1999.

The Attached documents are true and correct copies of the original documents for the patent application.

The German Patent and Trademark Office assigned to the application the preliminary symbols H 01 F and H 01 H for the International Patent Classification.

München, March 23, 2000
The German Patent and Trademark Office
The President
on the order of:

/s/ Dzierzon

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